Online Interactive Tutorials for Creating Graphs With Excel 2007 or 2010

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ABSTRACT

Graphic display of clinical data is a useful tool for the behavior-analytic clinician. However, graphs can sometimes be difficult to create. We describe how to access and use an online interactive tutorial that teaches the user to create a variety of graphs often used by behavior analysts. Three tutorials are provided that cover the basics of Microsoft Excel 2007 or 2010, creating graphs for clinical purposes, and creating graphs for research purposes. The uses for this interactive tutorial and other similar programs are discussed.

Keywords: chart, computer-based instruction, Excel, feedback, graph

Graphic data display is important to behavior analysts for several reasons. First, graphs allow the clinician to make immediate decisions regarding treatment effectiveness (Cooper, Heron, & Heward, 2007). Second, graphs provide a way to communicate treatment progress with interested parties such as parents, principals, or multidisciplinary team members. Graphic results of treatment can be easily shared by transferring the graphs to presentation software, uploading them to websites, or attaching them to emails. Third, the files created by most graphing programs can be saved and stored for future reference. Graphs created by behavior analysts represent a behavioral history for an individual. This history can be referenced should problems previously treated recur or skills relapse. Reviewing graphs from previous treatments may help inform the direction for future behavioral intervention.

Barriers to Graphing Data

Although well-designed graphs can be useful tools for the behavior-analytic clinician, the skills required to create the graphs may be difficult to master for a number of reasons. First, it can be difficult to find tools or features within graphing and spreadsheet programs that create common components of behavior-analytic graphs (e.g., a button for adding phase lines). Second, the user may find it difficult to locate assistance in the help functions of these software packages because they are rarely designed explicitly for the behavior analyst's needs. For example, searching "add phase lines" in Microsoft Excel provides no results applicable to adding phase lines to a graph. Some graphing programs provide additional functionality that makes graphing easier; however, those programs may be expensive and less widely available (e.g., GraphPad Prism, Sigma Plot). The default settings of commonly available programs (e.g., Microsoft Excel) lead beginners to create graphs that can make data interpretation difficult by adding unconventional color schemes, three-dimensional effects, and shadows. These problems can discourage clinicians from learning to create graphs that would be effective for data analysis and presentation.

Solutions

There are some solutions available to clinicians who want to learn to create common behavior-analytic graphs using the widely available Excel. Carr and Burkholder (1998) provided detailed task analyses for the creation of these graphs for users who have older versions of Excel. A more recent article has been published with updated task analyses for those users with Excel 2007 or 2010 (Dixon et al., 2009). These articles are useful for many people attempting to create specialized behavior-analytic graphs. However, each of these articles has some limitations. First, both articles teach the user to add phase lines using the drawing tools. This is problematic for a clinician who frequently updates graphs with new data. Manually inserted phase lines do not move when new data are added to graphs and might result in graphs with phase lines in the incorrect location. Uncorrected phase lines might result in problematic decisions based on the erroneous information. A second limitation exists in the updated article for Excel 2007 (Dixon et al.). The authors do not describe how to create bar graphs (or column graphs), which are often used to graph the results of preference assessments. Bar graphs are easier to create in Excel than other types of graphs, but there are a few features that users often miss that could enhance visual inspection. The third problem is that textual instructions cannot give a user feedback on their performance. Using articles to acquire graphing skills could be frustrating, particularly if the user has little experience using graphing software. For example, it might be difficult to determine why a particular graph

does not match an illustrative figure in an article after the user has followed the instructions.

A computer-based tutorial may solve these problems. The benefit of a computer-based tutorial, compared to text alone, is that the instruction can be interactive. The user can learn to create graphs by viewing a demonstration of the steps and then the user can try to complete the steps and receive feedback to correct any mistakes or reinforce correct completion of the skill. There are numerous research studies that demonstrate the importance of frequent opportunities to respond and receive feedback during skill acquisition (e.g., Kritch & Bostow, 1998). For example, Roscoe, Fisher, Glover, and Volkert (2006) trained adults to implement preference assessments using written instructions, monetary rewards, and feedback. The participants did not complete the preference assessments procedures with 100% accuracy in either the written instruction or monetary reward conditions; however, when feedback was provided, either alone or with a monetary reward, preference assessment procedures were implemented correctly. The findings of this study are particularly relevant for interactive tutorials such as this one where the discriminative properties of the feedback are maximized while the reinforcing properties of feedback are emphasized less (i.e., those in which feedback may occasion correct responses but known reinforcers such as money are not used). Clinicians may find the creation of tutorials using immediate discriminative feedback useful for training skills to parents or teachers related to computer software use, correctly implementing prescribed behavior programming, or other related skills.

The purpose of the current article is to provide the reader with information about a series of interactive tutorials available through the *Behavior Analysis in Practice* (*BAP*) website that teaches users to create behavior-analytic graphs. The tutorials cover many of the steps in the previously published articles on creating graphs using Excel. In addition, the new tutorials suggest different steps for creating phase lines that may be useful for clinicians and cover some additional graph types.

Accessing the Tutorial

Required Software

The most recent versions of Adobe Flash Player and Adobe Reader are required to run the tutorials. Many computers may already have these applications installed because they are
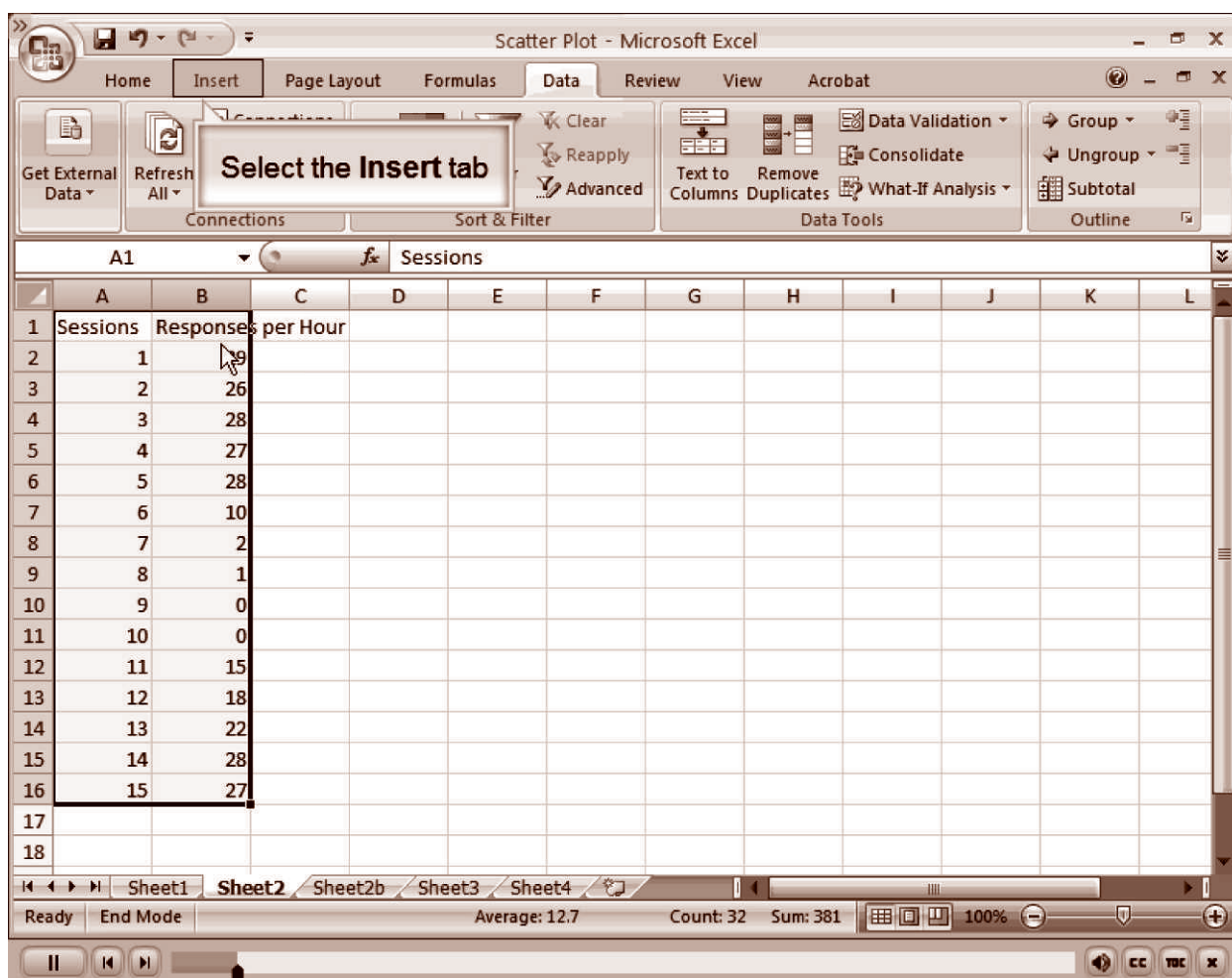

Figure 1. A screenshot of the tutorial informing the user how to insert a graph. At the bottom of the screen are controls that allow the user to pause, fast forward, rewind, or skip sections of the tutorial.

used by many popular websites. The newest versions can be freely downloaded from http://get.adobe.com/flashplayer/ and http://get.adobe.com/reader/. On the Adobe web page, click the "Agree and install now" button and then choose a location to save the file. To install the program, find the file on your computer and double-click on it to start the installation. Follow the onscreen prompts to finish the installation.

These tutorials were created for Microsoft Windows based computers (e.g., XP, Vista, or 7) and the Windows-based version of Microsoft Excel; however, users of Mac OS systems can access versions of the tutorials that do not include the interactive features. It should be noted that some of the screens and steps may be slightly different using the Mac OS version of Microsoft Excel. These users should download the Video Tutorials (see below).

Tutorial Files

Next, users will need to download the tutorial files. The files are available on the *BAP* website at http://www.abainternational.org/BAinPractice.asp. After navigating to the website click "Supplemental Materials" on the left side of the screen. There are two types of files available. The files with

the interactive components are available under the heading "Interactive Tutorials." These files contain the instructional content, testing, feedback, and other interactive features of the tutorials. These tutorials only work on Windows-based computers. The interactive tutorials are useful for learning how to make the graphs initially because they provide opportunities for the user to practice the steps and receive feedback. The files available under the heading "Video Tutorials" contain portable document format (PDF) files that can be opened on computers using either Microsoft Windows or Mac OS operating systems. These files contain the instructional content, but not the testing, feedback, or other interactive features. The PDF versions of the tutorials are useful for following along with the video while the user makes a graph or to look up particular steps or graphs. The tutorial begins automatically once the file is opened. The "Clinical Graphing" and "Research Graphing" tutorials are separated into three and four files, respectively. This allows the user to complete only a small segment at a time. To complete the entire tutorial, download all the files associated with the training. At the end of the interactive tutorials, close the program by pressing "Escape" on the keyboard or clicking the "X" in the bottom right corner before opening the next
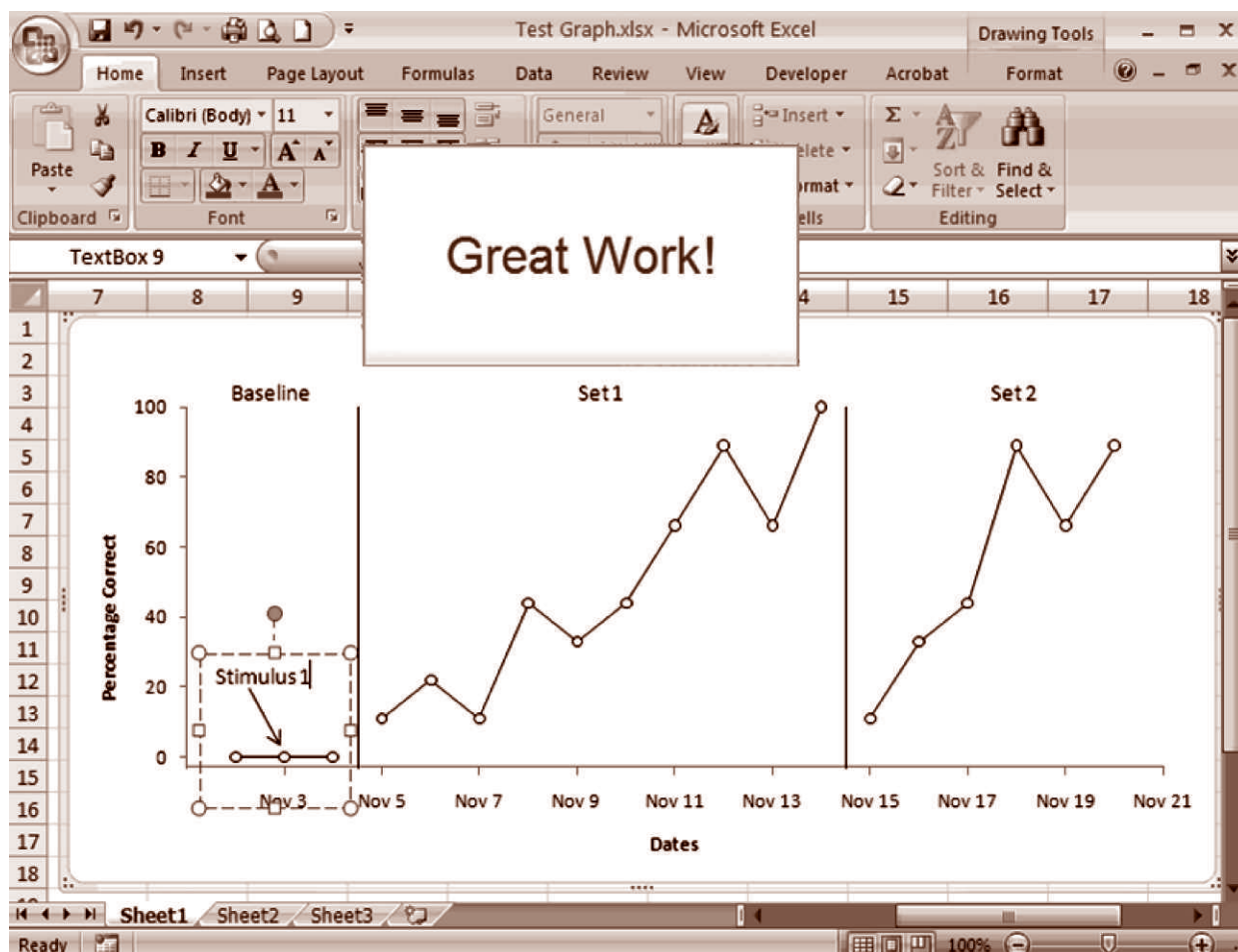
Figure 2. A screenshot of the tutorial providing feedback to the user.
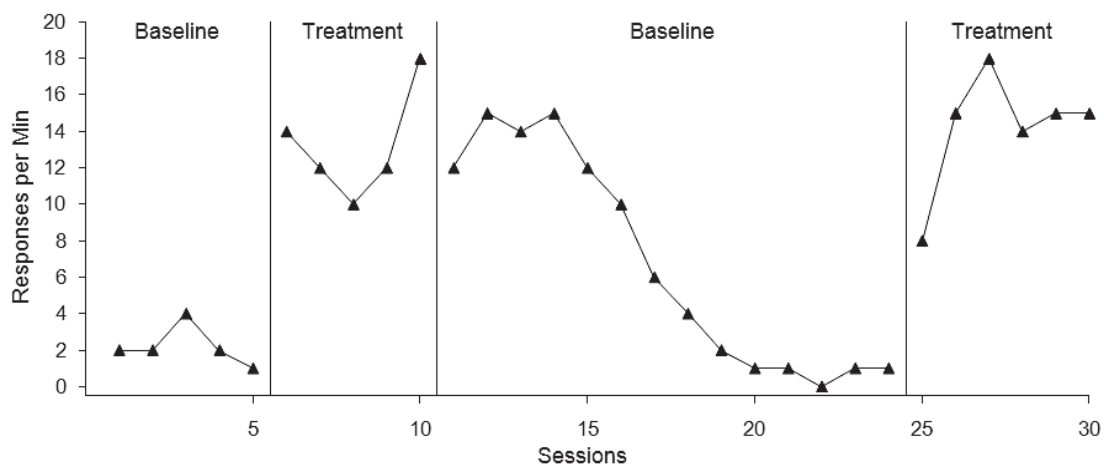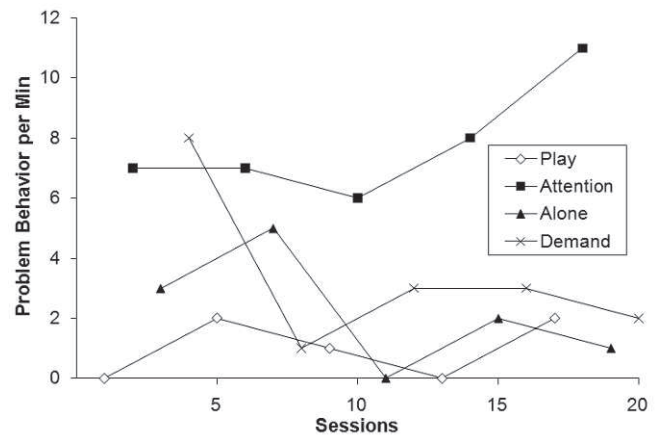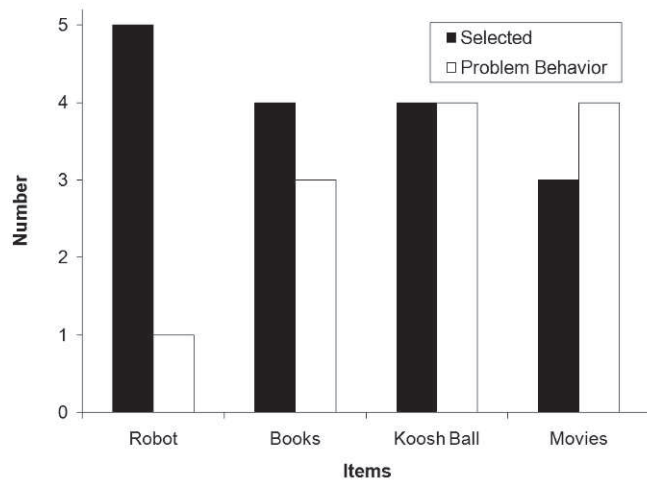
Figure 3. Sample graphs (with hypothetical data) created using the skills taught in the tutorials.

file. The files are ordered by number (e.g., Part 1, Part 2). The video-only files are PDF files that open in Adobe Reader and can be opened and closed like most applications.

Tutorial Information

All of the tutorials provide video representation of the steps required to make each graph with narration. The interactive tutorials also allow the user to practice the steps on a screen that looks the same as the screen in the Microsoft Windows version of Excel 2007. The screens may look slightly different in Excel 2010 due to minor changes to the file menu and the ability to customize the ribbon, but most of the steps will be completed the same way in both versions. Figure 1 illustrates a part of the program that provides instruction to the user. Figure 2 illustrates feedback that is presented after the user completes a task. In the interactive version of each program, the user is allowed two incorrect mouse clicks before returning to the instructions for the incomplete steps. Correct responses will allow the user to continue with the tutorial.

The user may want to skip some portions of the tutorial or exit the program before it is complete. In most interactive tutorials, the user can skip a section by using the controls at the bottom of the screen shown in Figure 1. The user may exit the training at any time by pressing the "Escape" key on the keyboard or clicking the "X" at the bottom right corner of the screen. The program will not save the current location at exit; however, one can easily resume a location by using the controls at the bottom of the screen.

There are three tutorials provided on the website. Each tutorial covers different material and is designed for different audiences. The list of skills taught in each of the tutorials is presented in Table 1. The first tutorial, "Introduction to Office 2007," provides some general information about changes in the newer versions of Microsoft Office. This tutorial is important because it clarifies some of the terminology used in future tutorials. Users may not need to view the material in that tutorial if you are already familiar with the new versions of Excel. The second tutorial, "Clinical Graphing," is designed for users

Table 1. List of Competencies

Introduction to Office 2007	Clinical Graphing	Research Graphing
Understand terminology and basic functions of Microsoft Office 2007	• Review the parts of scatter plots (line graphs) and bar graphs • *Bar Graphs* • Understand when to use • Set up data • Create the graph • Add additional data • Add an additional bar • Add axis labels • Format the graph • Sort the data • *Scatter Plots* • Understand when to use • Set up data • Create a scatter plot • Add axis labels • Format a scatter plot • Add multiple data paths • Add phase lines and phase labels • Use chart templates • Move graphs within Excel • Export graphs to PowerPoint	• Review the parts of scatter plots (line graphs) • Set up data • Create a basic scatter plot • Add axis labels • Format the scatter plot • Float the zero • Add phase lines and phase labels • Add data path labels

Table 2. Duration of Instructional Content

	Introduction to Office 2007	Clinical Graphing	Research Graphing
Total	12 min	28 min	18.5 min
Part I		12 min	4 min
Part II		12 min	5 min
Part III		4 min	3 min
Part IV			6.5 min
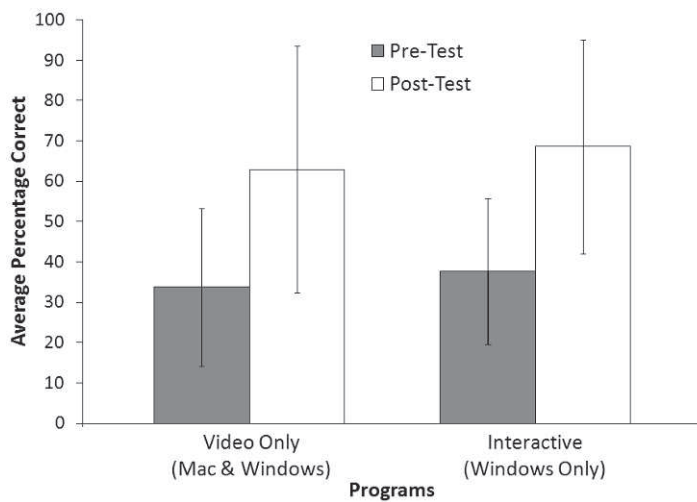
Figure 4. Average percentage correct for reversal-design graphs before and after completing the video only (n = 5) or interactive (n = 5) versions of the Research Graphing tutorial. Error bars indicate one standard deviation above and below the mean.

who need to make graphs for clinical purposes. This tutorial provides the most information about commonly used graph types, including bar graphs, reversal design graphs, and multielement design graphs (see Figure 3 for examples). Although not discussed directly, users can create multiple baseline design graphs by copying and pasting many reversal design graphs. The third tutorial, "Research Graphing," covers some of the same information in the Clinical Graphing tutorial, but also provides additional information for creating graphs that are to be published in scientific journals. For example, the Research Graphing tutorial covers floating (raising) the zero on the *y*-axis above the *x*-axis.

Evaluation

Employees at our organization who were novice graph makers were recruited to assist in evaluating the tutorials to test for clarity and usability. These participants worked at a residential school for children with intellectual disabilities and indicated that graphing in Excel was relevant to their current jobs. All participants reported that they had some experience using Microsoft Excel. Ten of the employees who completed the Research Graphing tutorial then also completed pretests and posttests for this section of the training.

The duration required to complete each tutorial was determined from the initial tests for usability (see Table 2). The duration of tutorials with interactive tests varied across users, but was generally twice the duration to view only the instructional content. For example, it took our test users 28 min to watch instruction in the Clinical Graphing tutorial and approximately 1 hour to complete the tutorial with the tests. Although the test versions of the tutorial may take longer to

complete, the feedback provided by those tutorials should be beneficial for users who are unfamiliar with creating graphs using Excel.

Ten participants were randomly assigned into two groups of five to evaluate the Research Graphing tutorial. One group completed the interactive tutorial; the other only watched the associated video. Participants in both groups completed a pretest before the tutorial and a posttest immediately following the tutorial. The tutorial could only be viewed once and the participant could not access the tutorial during the pretest or posttest (which were identical). During these tests, the experimenter provided participants with a written prompt to create a reversal-design graph using Microsoft Excel and the data provided. The test was scored according to 35 criteria of effective graphs such as phase lines (created according to the method used in the tutorial), the zero on the *y*-axis floated slightly above the *x*-axis, and appropriate graph type within Excel (scatter plot). Other stylistic concerns were also scored including using only grayscale colors, no bold fonts, and centered phase labels.

Figure 4 displays the mean pretest and posttest scores for both groups (video only, interactive). The mean posttest scores exceeded the mean pretest scores for both groups, and there was no difference in the effects of video and interactive trainings. The modest performance during posttests could have conceivably been higher had participants been able to access the tutorial while completing the posttest. That said, future users may find the video version of the tutorial a useful reference while creating graphs, perhaps improving the quality of graphs beyond what was observed in this brief evaluation

Conclusion

The resources provided online in association with this article may be useful for clinicians in a variety of ways. First, the tutorial may help clinicians create graphs that will be useful for making clinical decisions about programs and communicating consumer progress with interested parties. Second, clinicians might consider providing this training for parents and teachers so they can learn to create these graphs as well. This may be beneficial for clinicians because parents or teachers can create graphs of behavior that can be shared electronically with with consultants. Third, this resource could be used as a model for tutorials that could be created for other skills.

The relative effectiveness and efficiency of learning to graph with an interactive tutorial versus other methods (e.g., reading an article or searching the help menu) is currently unknown. Future research that examines the extent to which computerized training is useful is important because of the frequent advances in computer programming and the relative ease with which trainings such as these could be provided over the Internet. For example, an experimenter may attempt to teach participants a subset of skills (e.g., floating the zero on the *y*-axis) by providing written instructions such as the article by Dixon et al. (2009) and a different subset of skills (e.g., adding

phase lines) using computer-based training and comparing the efficacy and efficiency of the two methods.

Creating and updating behavior-analytic graphs in Excel can be a tiresome and frustrating experience. Hopefully, the computer-based tutorial provided through the *Behavior Analysis in Practice* website may alleviate some of the more time-consuming problems clinicians encounter such as adjusting phase lines each time data are added. Future research on the incorporation of behavior-analytic principles into such tutorials may help determine the efficacy and generality of computer-based instruction to teach a wide variety of skills.

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